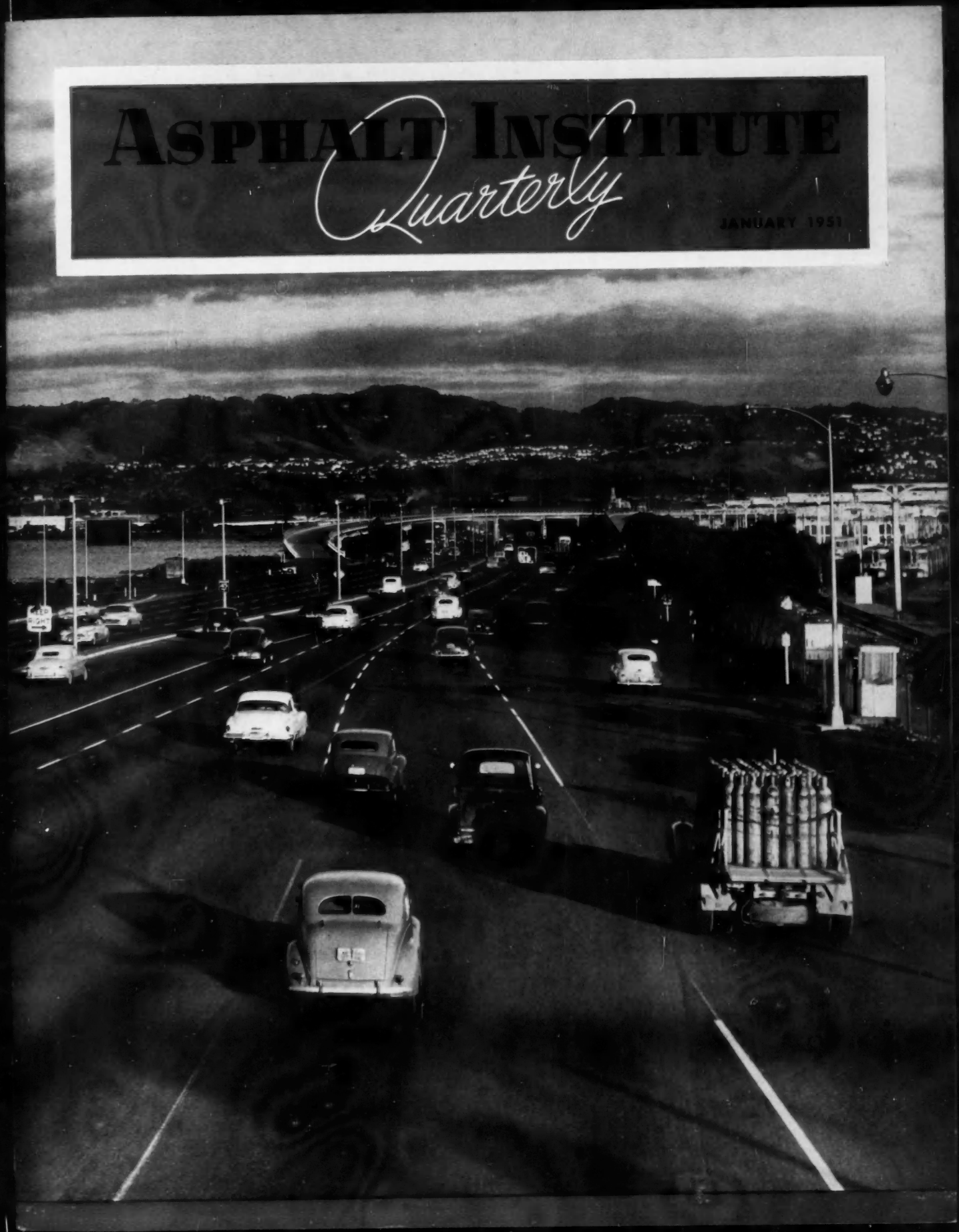
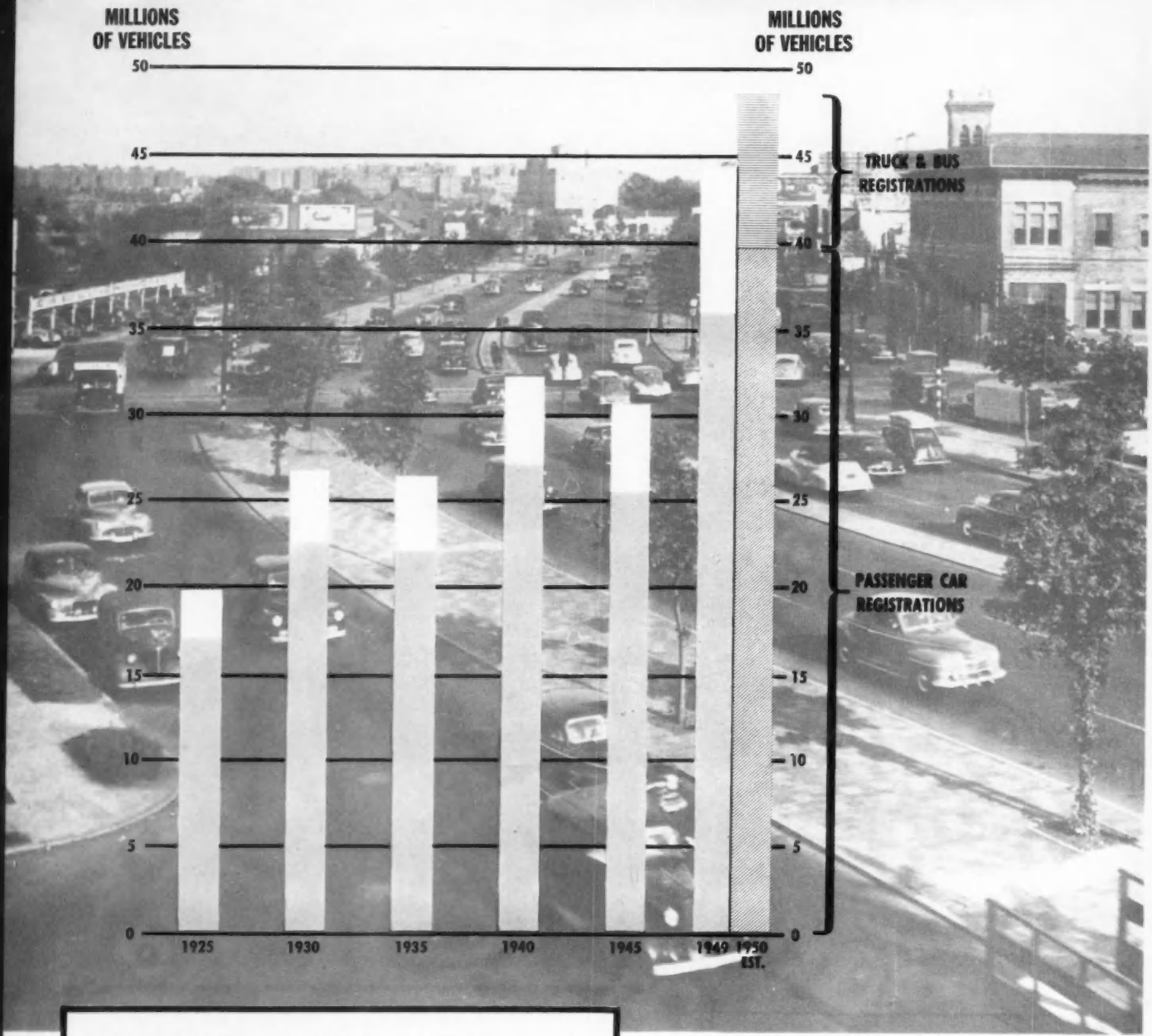
Asphalt Institute Quarterly

JANUARY 1951



MOTOR VEHICLE REGISTRATIONS IN THE UNITED STATES 1925-1950



This Chart indicates that, in the past five years, passenger car totals have increased more than 50 per cent, and truck and bus totals approximately 80 per cent. Combined with these increases, the greater *MILEAGE, WIDTH, LENGTH, AND LOAD* per vehicle now demand road and street carrying capacities varying from two to eight times those of 1945.

- TRUCK & BUS REGISTRATIONS
- PASSENGER CAR REGISTRATIONS
- 1950 ESTIMATED TRUCK & BUS REGISTRATIONS
- 1950 ESTIMATED PASSENGER CAR REGISTRATIONS

Charted by the Asphalt Institute, January 1951 • Source: U. S. Bureau of Public Roads Figures

ASPHALT INSTITUTE Quarterly

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The names of the Member Companies of the Institute, who have made possible the publication of this magazine, are listed herein on page 15.

EDITORS

Bernard E. Gray, *President of The Asphalt Institute*
Ernest M. Bristol, *Director of Public Relations*

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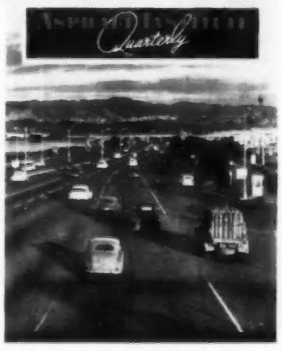
COVER



Featured on the double covers is the heavy-duty asphalt-paved approach to the record-traffic-carrying San Francisco-Oakland Bay Bridge. This picture was taken from the Toll Plaza, looking back toward Oakland to the right and includes, on the back cover, a distant view of Berkeley, the University of California, and the Berkeley Hills.

For the Registrations Chart, on the opposite page, there is included as appropriate heavy-duty background a view of asphalt-paved Queens Boulevard. This "dual-dual," ten-lane, traffic artery serves as a corridor connecting Long Island, via mid-town tunnel and bridge, with New York. *Photo: Galloway*

EDITORIAL

Never before in the history of transportation has the time been as critical as the present. Whatever the course of international relations, it is evident that for an unpredictable number of years great emphasis will be placed upon military preparations and that, coupled with civilian requirements, industry will be engaged to its maximum capacity. The great material advantage of the United States is its ability to manufacture in huge quantities with minimum utilization of labor. Its productive capacity in this regard is equal in many respects to all of the rest of the world combined. To keep this industrial plant working at maximum efficiency, however, requires the most careful coordination of *all* elements, to make the finished product possible.

Of these elements probably the most important is the item of transportation, which includes the highways, the railroads, and the airways. These three must be so efficiently maintained and coordinated that in no place, nor at any time, will there be delay in the delivery of raw materials, semi-finished parts, or personnel. Accordingly, any conflict existing between these several forms of transportation should be resolved at the earliest possible moment. The *where* and *when* of traffic are its vital factors. Traffic must move *where* it is going in a minimum of distance for economy of movement; but, even more important, it must move there *when* it is needed for economy of time. In meeting these requirements, the truck often has advantage over the railroad, and the airplane over both.

Now it is no secret that, with the tremendous growth of trucking during the past five years (See chart—page 2), bitter opposition to the larger units has come from many sources, even though this growth was forecast as early as 1936. What are the facts now, and where should the limits be set? So-called remedial legislation often goes too far, and in light of present conditions it is certainly not in the public interest to permit unnecessary restrictions upon loads which may be carried by trucks on the interstate highways. Yet conversely, way overweight trucks, so insignificant in numbers as related to the trucking industry as a whole, should not be permitted to bring about congestion and destruction of surfaces out of all proportion to their usefulness.

Obviously, large trucks are a necessity and the present question is—shall highways be rebuilt to carry them and thus take care of possible emergency conditions, or shall the truck be restricted to the capacity of the weakest highway? Somehow the latter procedure would seem a backward step, particularly now when all restrictions may have to be removed. A far better plan would seem to be one of evaluating at once a minimum mileage of main trucking routes in respect to present load-carrying capacity, and then immediately to strengthen all deficient sections to achieve some standard that conforms more nearly to required usages.

It is the purpose of this issue of the Quarterly to discuss some of these relationships in their historical development and to suggest methods whereby more complete efficiency of highway transportation may be achieved.

Charted by the Asphalt Institute, January 1951 • Source: U. S. Bureau of Public Roads Figures

WHAT LOADS ON WHAT HIGHWAYS?

Asphaltic concrete resurfacing in the Holland Tunnel between New Jersey and New York.

U. S. 101 — Asphaltic concrete on Golden Gate Bridge Approach—San Francisco in background.

A controversy, underway for over a hundred years, but with growing intensity for the past twenty, is now reaching a climax. The manner in which it is handled will have a profound effect on taxation, the cost of living, and even the safety of the country. Fundamentally it concerns the competition between two forms of transportation, the railroad and the highway, although for the moment this basic fact is lost to sight by reason of a secondary controversy over damage to highway pavements alleged to be caused by heavy motor trucks. Relatively little concern seems to be evidenced that the truck may be more important than the highway, and at the 1951 sessions of the Legislatures in a number of States no doubt an attempt will be made to fix by law the maximum axle load for trucks at 18,000 pounds.

The real underlying question before these Legislatures, however, will be whether transportation progress can be stopped at some specific point by governmental edict, and the country thus prevented from enjoying the full benefits of invention and enterprise. Is the truck really at fault, or is it delay in adjusting the existing highways to modern needs, that is the real trouble?

Why should it be necessary to limit highway loads to 18,000 pounds per axle when the motor vehicle itself is not so limited from an economic operating standpoint? Why may the load not be 20,000 or 22,000 or 25,000 pounds per axle, inasmuch as the heaviest one may be carried readily so far as axles, wheels, and tires are concerned? Is the limitation possibly in the roadbed, and is it only economically practicable to build roads that will just carry this 18,000 pounds per axle and no more? Such a conclusion would hardly seem borne out in fact, because gross loads of 20,000 to 100,000 pounds are common on airfields, while the private logging roads of the great lumbering companies in the Northwest are subjected every

U. S. 50 in Virginia. Asphaltic concrete over gravel base.

Merritt Parkway, Connecticut. Asphalt resurfacing in foreground.

day to truck loads far in excess of those carried on even the most heavily traveled public highways. What then is the real truth of the matter, and what should be the solution of the problem? A brief review of transportation history may possibly place the matter in true perspective, so that a better understanding can be had as to what is involved.

EARLY TRANSPORTATION HISTORY

First, it cannot be too strongly emphasized that it is *the vehicle* and not the pathway that will determine ultimately the outcome. Roads are built to serve the vehicle, not to be masters of it. When the only vehicle was an animal, the pathway was everywhere but, except with special couriers as in the Middle Ages and the Pony Express of the early western days, traffic was limited indeed. With the development of the wheel, improved pathways came into being to serve the wagons and carriages and even horse cars that followed in due course. With wrought iron more available for tires and body reinforcement there developed competition between carriage manufacturers every whit as keen as that prevailing between the present day makers of cars and trucks. The great migrations across the Alleghanies and on westward to the Pacific were carried in wagons and, to serve this traffic, there was a considerable building of a better kind of pathway.

From 1830 on in America, for several decades, untold thousands of horse-drawn vehicles traversed the Old National Road and many other historic routes which rapidly were built to meet the growing highway needs. Then something happened! A new vehicle, "The Iron Horse," slowly but surely asserted its superiority over the flesh and blood animal, and traffic on these highways, once so continually thronged, gradually dwindled to insignificance as the people changed their long distance travel habits and moved by railroad. Even the great Northwestern Turnpike across Virginia, built by Croset, became so little used that when roadbuilding again was resumed in the early 1920's, trees two feet in diameter were growing in the middle of the right-of-way on the mountain sections.

Why was roadbuilding resumed? Again it was because of a new vehicle. The automobile, with its greater flexibility of operation, was for many uses becoming more efficient than the locomotive, and would not be denied. It is all very well to assert that the highways were subsidized but, as with the railroads, such aid would never have been given had not the merit of the vehicle itself demanded it. The superiority has increased to this day and, until the railroads discover some more efficient method of operation, the motor vehicle moving over the highway will be preferred for a large part of both passenger and freight traffic.

Now this does not mean, of course, that railroads will go the way of the horsedrawn wagon, for they are indispensable, but it does mean that the truck, in all sizes, is here to stay until some other more efficient form of transport appears over the horizon of research and development. The railroads haul for as low as 1¢ per ton mile, while it generally costs several times that amount to move a ton of freight over the highway; but as long as railroad terminal costs remain unchanged, coupled with annoying and often costly delays in delivery to house, store, and factory, the public will demand that a large part of their goods come all the way by highway.

THE LOAD AND THE PAVEMENT

So much for one aspect of the problem. The secondary part of the controversy is the one dealing with damage to highway pavements alleged to be caused by trucks, particularly as relating to rigid types. True, competition between pavement types is not new, and a hundred years ago promoters of brick, granite block, wooden block, macadam, and even plank pavements were actively urging the merit of their respective products. They all realized that it was desirable to have a well-drained earth foundation for any pavement, but often they gave the same degree of lip service to this basic requirement as is found all too frequently in modern times. Everyone was hoping that some panacea type would be developed that would easily take care of wet and soft subgrades, and thus be of "permanent" character.

With the improvement in hydraulic cement, the idea was conceived that if *a rigid slab* were constructed, it would bridge over the weak areas, and thus there was developed the so-called "concrete" road. Skillful and able promotional effort was placed behind the idea and a great deal of money and time expended in bringing this type of construction into widespread use. Such pavements have served quite well in many areas, and often were economical to construct. However, it is desirable to look into the basis for the cross-section which became so widely adopted, because it is at the bottom of much of the present difference of opinion concerning truck loading and pavement damage.

In order to provide for easy computation of pavement stresses a simple formula was selected for the design of this "concrete." Of course before any formula can be written it is necessary to make certain assumptions, which if correct will lead to correct answers but, if even partially in error, their use naturally will result in answers which are incorrect in some degree. What were these assumptions? In brief, it was assumed that the subgrade would be uniform in support, that the pavement itself would be of uniform strength, and that some maximum load would neither be exceeded nor applied more than a certain number of times. This maximum load was considered to be not much if any over 9,000 pounds per wheel.

Now in those late years of the twenties' when the present formulae were largely initiated, it hardly seemed likely that trucks would reach the size and weight which has since become practicable, hence the assump-

Continued on page 6

Stockton Test Track, California. Asphalt pavement under test with 200,000 pound wheel-loads.

Test trucks on South Section, Maryland Test Road No. 1.

Test truck on asphalt surface turnaround, on same Test Road.

U. S. 101, State of Washington. Asphalt surface on flexible base.

WIDENING

Above: Narrow width leads to over-stressing on many miles of old concrete pavement.

Below: Narrow pavement after widening and resurfacing.

tions were not unreasonable. Those who were highway builders twenty-five years ago and recall the difficulty in operating trucks because of breakdowns of one kind or another, still marvel at the great advances made in the development of the balloon tire, the alloy steels and light weight metals which make the present vehicles so efficient. In those earlier years wheel loads of 9,000 pounds were unusual, and that future loading of such amounts would be commonplace, could hardly be foreseen. Even if so, it would not have been economical design to have anticipated such development, particularly as it always has been a basic principle of any transportation design first to get a system built and then pay for improvements out of earnings.

FLEXIBLE VERSUS RIGID TYPES

On this reasoning something over 100,000 miles of rigid "concrete" pavements were constructed on the main highways of the United States. There were many discussions over the following years as to whether they should have this kind of steel reinforcing or that, whether or not load transfer devices were required, and whether or not joints should be spaced at one interval or another. Basically and all important, however, is the fact that *these roads were designed* in the first instance and for many years thereafter, with view to wheel loads *not much in excess of 9,000 pounds*, and this has much to do with the presently proposed limitation of 18,000 pounds per axle.

All went well until the beginning of the second world war, and then loading really did begin to increase both in unit weight and volume. However, in spite of inadequate maintenance, many pavements carried through in fair condition until the war ended, although it was quite evident that rehabilitation could not be long deferred. Since the end of the war the further increase in the use of trucks, however, has been phenomenal. (See Chart — page 2). Not only have they increased in numbers, they have increased in weight and size so that, plus the increased rate of use, there was truck traffic in 1950 many, many, times what it was in 1945. The result, of course, is that pavements which were designed quite accurately to carry 1930 and 1940 loads are now inadequate. *But what of it? Is it not to be expected?* The railroads place as heavy as 155 pound rail on some routes and lesser weights on others. Is not the principle the same? The very fact that truck use has increased at such a rapid rate is evidence in itself that our modern society requires such service and hence it is purely *a business proposition* to provide the necessary roadways over which they run. How is this to be accomplished? A little more history may be helpful.

During the period of intensive building of the "concrete" pavement there was likewise great expansion of the "flexible" pavement type, composed of gravel, macadam, slag and a great variety of other local materials available at low cost as foundations. Such pavements do not bridge weak areas, but maintain continuous contact with the subgrade. While they too were designed in accordance with current traffic requirements, little by little it was discovered that they could be resurfaced with an inch or more of new material should certain sections require it, and thus was developed the so-called "stage construction" idea whereby an untreated macadam or gravel road was changed to a surface treated one, then to a mixed surface, and later to a heavy duty asphalt type if necessary to meet increased demand.

For some curious reason there was a reluctance to carry on similar stage strengthening of "concrete" pavements, until very recently, with the result that breakdown of these surfaces has appeared more spectacular and the public has become confused as to the basic causes. By 1949 so many doubts had been raised that a representative "concrete" road in Maryland was selected for test as an object lesson, to prove that heavy trucks were to blame for all pavement failures, and hence should be limited to some arbitrary loading based upon the old designs. While no final report yet has been made,

U. S 30, Idaho, widened and resurfaced with asphalt.

Trucks using third lane upgrade.

from the progress reports it is quite evident that behavior has been exactly as expected, namely, that a rigid "concrete" slab designed to carry 18,000 pound axle loads will fail if subjected to greater loads, particularly when repetition produces fatigue.

Now for some years there has been growing doubt that the rigid design is economical under present day conditions. With the development of the science of soil mechanics, and experience with heavy duty airfield construction, it has become more and more evident that the important parts of a pavement are the well drained subgrade and a flexible foundation. Once these are in place it is only necessary to provide a waterproof top to carry the heaviest wheel loads. It is perfectly possible, of course, to design a rigid "concrete" pavement to carry any load, but the cost is greatly in excess of what can be accomplished by utilizing to the fullest extent the locally available aggregates and selected soils in such foundations. Thus we have another phase of the controversy wherein one type of pavement seems to be slowly losing its economic advantage and naturally resists such displacement, just as the railroads naturally resisted the truck.

TRANSPORTATION COORDINATION

Now all this argument and confusion might be supported in normal times, and somehow adjusted through the usual processes of competition. But the country is facing a serious emergency, and it will need to use trucks to their economic capacity, just as it will require the use of railroads to their limit. Instead of blaming the truck operator, as in a number of states, it would seem the better plan to establish some more modern weight limitation, through agreement between the truck manufacturers, the truck operators, and the State Highway Departments.

It is unfortunate that the public has been led into believing that if heavier trucks are in general use they will run all over the country and break down the lighter roads. This is, of course, purely a matter of police control and certainly, with the major trucking associations entering into appropriate agreements with the State Highway Departments as to the routes over which heavy trucks would operate, little danger in this regard need be experienced. In railroad operation the heaviest equipment does not run hit-or-miss along branch lines, and there is no reason why any different practice should be had on the highway. Recent conversations with some of the truck association heads indicate that they have definite information concerning the routes over which the heavier trucks operate, and that this mileage is but a small per cent of the total.

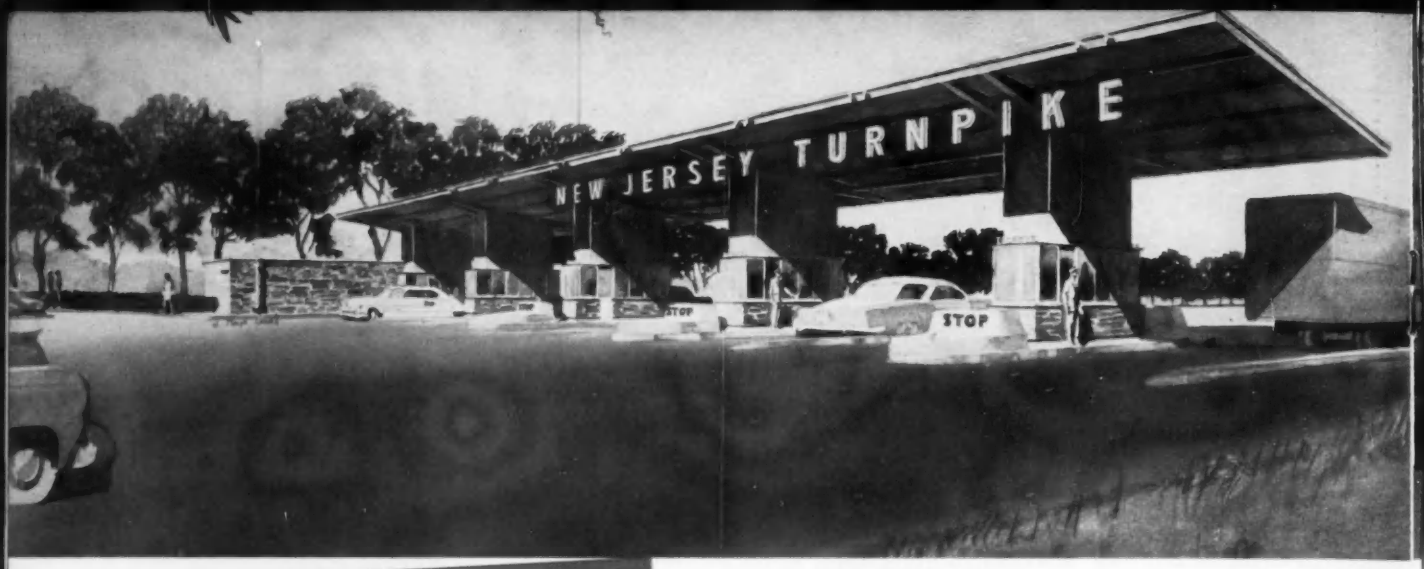
The immediate need then is to select this mileage, evaluate its condition, and then proceed to the necessary improvement. Further details in this regard may be found in the article "More Roads for Less Money" beginning on page 10. Suffice it to say here that any of the "concrete" pavements now breaking down under 18,000 pounds axle loads can be strengthened almost overnight by the very simple procedure of (1) "undersealing" with hard bitumen which fills the voids, *thereby providing a truly uniform subgrade support,* and (2) resurfacing with a bituminous top to waterproof the pavement and better distribute the load, so that further disintegration will be prevented.

Flexible pavements do not require undersealing but may be similarly strengthened by resurfacing. Such rehabilitation processes will solve the problem of heavy truck loading damage, and will place our main heavy duty highways in condition to meet the most severe war demands, through making use of the motor truck to its full economic capacity.

UNDERSEALING

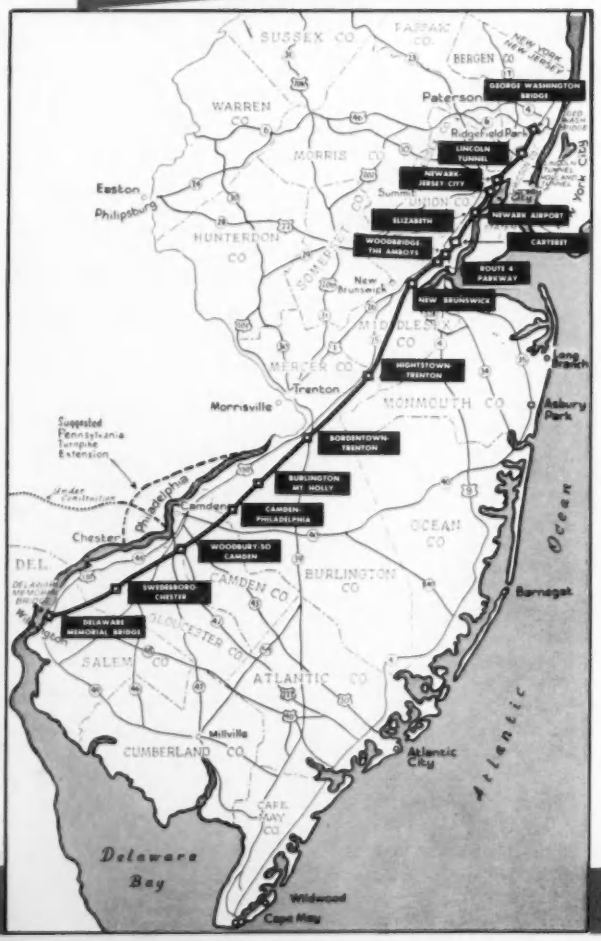
Above: Special rig for drilling three holes simultaneously, preparatory to undersealing.

Below: Pumping hard asphalt under concrete pavement to fill cavities.



DESIGN FOR TOLL PLAZA.

Asphalt To Pave New Jersey Turnpike



Map of New Jersey Turnpike. (Six-lane from Lincoln Tunnel to Route 35; balance four-lane.)

"Trenton, N. J., November 30—After careful consideration of all factors involving pavement, such as cost, durability and safety features, the Commissioners of the New Jersey Turnpike Authority have decided to use asphaltic concrete for the pavement of its 118-mile super-highway, it was announced today by Paul L. Troast, Chairman of the Authority."

Above is the opening paragraph of the November 30th 1950 Release by the New Jersey Turnpike Authority announcing its choice of asphaltic concrete. As awarded, the saving on the asphalt design, representing the total difference between the competitive bids, amounted to $5,420,134.

This decision followed an exhaustive study of the merits of competing pavement types. In August 1949, the Asphalt Institute was invited to present before the Turnpike Authority the merits of pavement construction using a flexible base and asphalt wearing course. In complying, the Institute advocated the construction of an asphaltic concrete wearing surface under which was to be placed a certain depth of macadam stone as a base, all to be supported on a sub-base and subgrade the thickness of which was to be determined in accordance with load-bearing tests then being taken by the Consulting Engineers.

On August 21, 1950, the preliminary report of the Consulting Engineers was issued, calling for the design of two alternate types of pavement, one of asphalt and one of portland cement concrete. The asphalt design provided for 4½″ of dense graded asphaltic concrete mixture, on an 8″ macadam stone base, the top 2″ penetrated with asphalt cement and this base in turn on 6″ of stone or gravel subbase, a total of 18½″. This pavement structure is placed upon a subgrade composed of selected soil material, which is thoroughly compacted by most modern methods.

LOCATION

The New Jersey Turnpike is planned to cross the State in a north-east direction in a relatively straight line from Deepwater, the New Jersey terminus of the Delaware

Layout of Toll Interchange for Route 25 (left). Portion of interchange during grading (inset).
Air-photo of graded section of turnpike from Route 4 Parkway to Morse's Creek (right).

Memorial Bridge now under construction across the Delaware River, to the vicinity of the George Washington Bridge. It will connect southern and western states with the New York metropolitan area and points north in New York State and northeast in New England. Starting at Deepwater, the Turnpike will roughly parallel the Delaware River, pass close to the Philadelphia-Camden and Trenton areas, thence traverse the industrial areas of Elizabeth and Newark, and then connect with roads leading to the Holland and Lincoln Tunnels and the George Washington Bridge. Access throughout will be provided to centers of population and industry.

In boldness of conception this Turnpike is unquestionably the largest highway project ever built. The State of New Jersey has been referred to as "a corridor state" with two of the largest cities in the United States contiguous to it and, therefore, necessitating the heaviest traffic placed on any highway in the United States. In addition, the products of the farm and factory from the South, as well as from the West, will eventually find their way to this Turnpike. It was, therefore, incumbent upon the designing engineers to provide a highway able to support not only the volume of traffic expected but also the maximum weights at present using our highways. The design, therefore, was predicated upon a gross axle load of 36,000 pounds, much heavier than that used in the design of heavy-duty highways on the State Highway System.

MERITS OF ASPHALT

The design features of all installations of the Turnpike were placed in the hands of several outstanding consulting engineers, together with the engineers of the Turnpike Authority, and they are responsible for both design and construction. In fact, in its announcement of its decision to use asphalt, the New Jersey Turnpike Authority included the following statement:

"The decision was made, too, in consultation with our own engineers, and those of our special Paving Committee, who declared that the bids were sought on a comparable competitive basis, and assurance from the engineers that in using asphaltic concrete—

(1) the Turnpike will be superior to any road in existence;

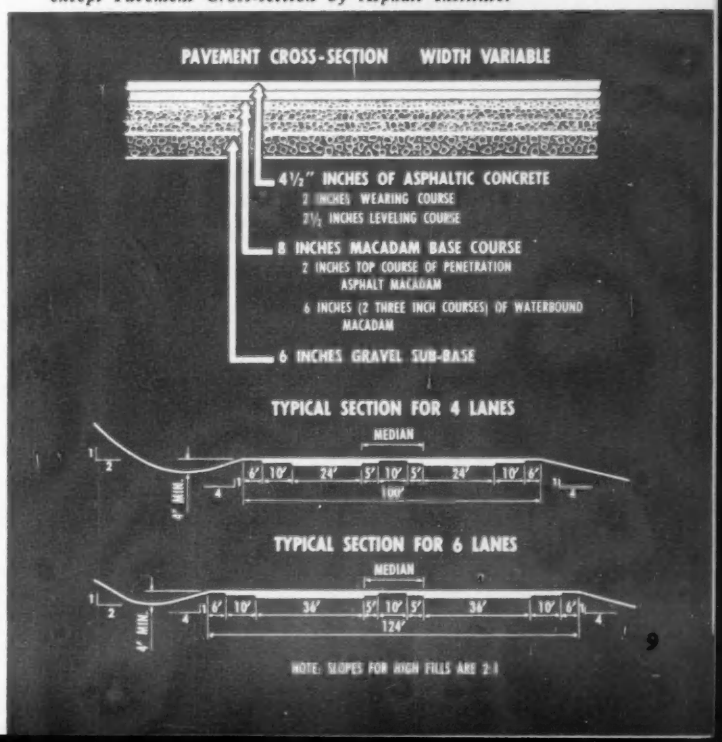
(2) asphaltic concrete will provide a substantial margin over the anticipated heaviest loads to be carried; and

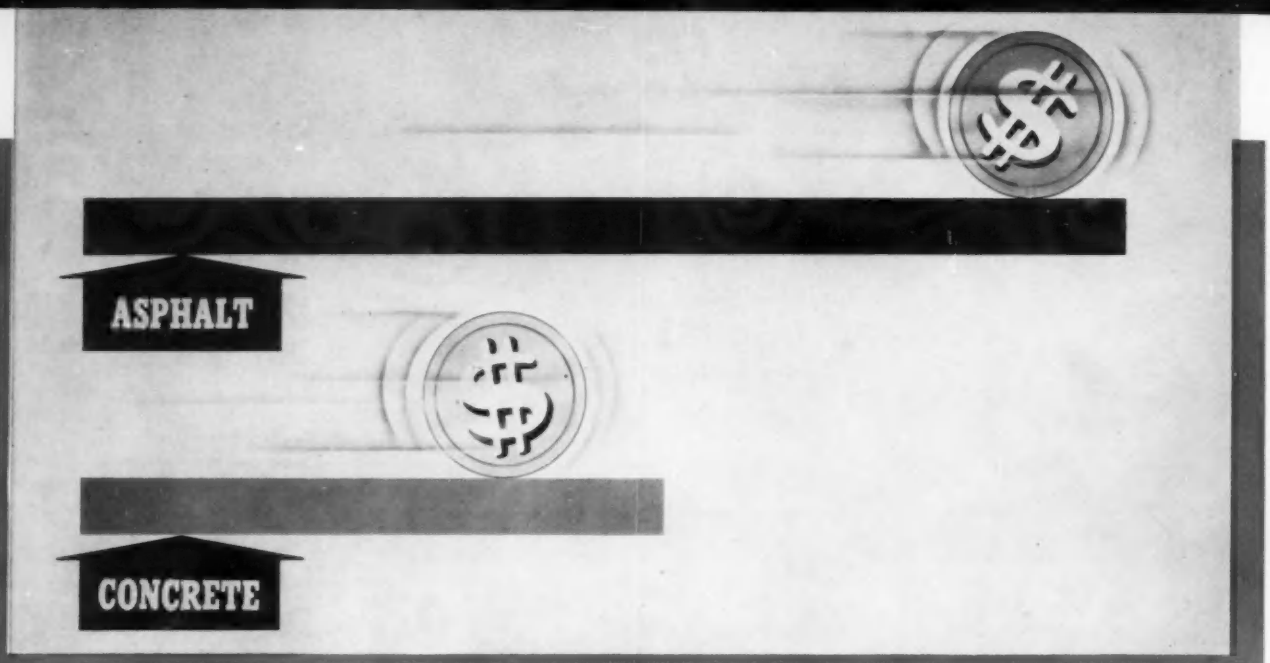
(3) asphaltic concrete will provide an excellent riding surface combining all the safety features available in any other type of highway, in all kinds of weather, and at high speeds. The asphaltic pavement, as designed, will supply a non-skid surface that is the equivalent to the best available anywhere."

COMPLETION DATES

The scheduled date for completion of the Delaware Memorial Bridge is July 1st, 1951, and for the New Jersey Turnpike itself November 15th, 1951.

Illustrations — Courtesy of New Jersey Turnpike Authority; except Pavement Cross-section by Asphalt Institute.


PAVEMENT CROSS-SECTION WIDTH VARIABLE
4½" INCHES OF ASPHALTIC CONCRETE
2 INCHES WEARING COURSE
2½ INCHES LEVELING COURSE
8 INCHES MACADAM BASE COURSE
2 INCHES TOP COURSE OF PENETRATION ASPHALT MACADAM
6 INCHES (2 THREE INCH COURSES) OF WATERBOUND MACADAM
6 INCHES GRAVEL SUB-BASE
TYPICAL SECTION FOR 4 LANES
MEDIAN
6' 10' 24' 5' 10' 5' 24' 10' 6'
100'
4" MIN.
TYPICAL SECTION FOR 6 LANES
MEDIAN
6' 10' 36' 5' 10' 5' 36' 10' 6'
124'
4" MIN.
NOTE: SLOPES FOR HIGH FILLS ARE 2:1



THE HIGHWAY DOLLAR GOES FURTHER WITH ASPHALT

MORE ROADS FOR LESS MONEY

A brief, based upon the paper by Bernard E. Gray, President of The Asphalt Institute, presented to the Highway Committee of the American Petroleum Institute, at Los Angeles, November 14, 1950.

Highways are big business and, like all big business, are affected by many and various factors. In recent months there has been intensified emphasis on the need for a new "big-big" road system, and one often reads that the present one is all but completely worn out. For example, the August Harpers had an article entitled "Our Roads Are Going to Pot." The Saturday Evening Post, of September 16th, had another on how the trucks were destroying the highways. Few people indeed would deny that a completely adequate highway system is essential to our welfare and prosperity, but are these assertions of calamity around the corner correct, or are there influences other than true economic ones back of these demands? Do some roads cost more than is necessary, and are there alternate methods of use possible which would produce desired results for less money?

It has been my privilege to have been associated with the highway program for over forty years. One half of that period was with two state highway departments and the federal Bureau of Public Roads, while the past twenty years have been on the industry side. In the course of these years, first-hand studies have been made in the forty-eight states, and current observations lead to a very definite knowledge of present conditions. And so, relative to the statement "Our Roads Are Going to Pot," it simply is not so. No doubt the title was employed for its dramatic touch. Actually the highways of America, as a whole, are in far better condition today than they were in 1940, notwithstanding some spectacular exceptions, usually "concrete."

Why then the constant theme that our roads are in such deplorable condition? The answer, of course, is that while the highways in general are better than they were ten years ago, increase in volume and weight of traffic has been so rapid that by contrast we appear to be losing ground. Actually great gains have been made and with *intelligent further modernization of existing roads*, only a very limited mileage of new roads will be required to restore a proper balance with present and future needs.

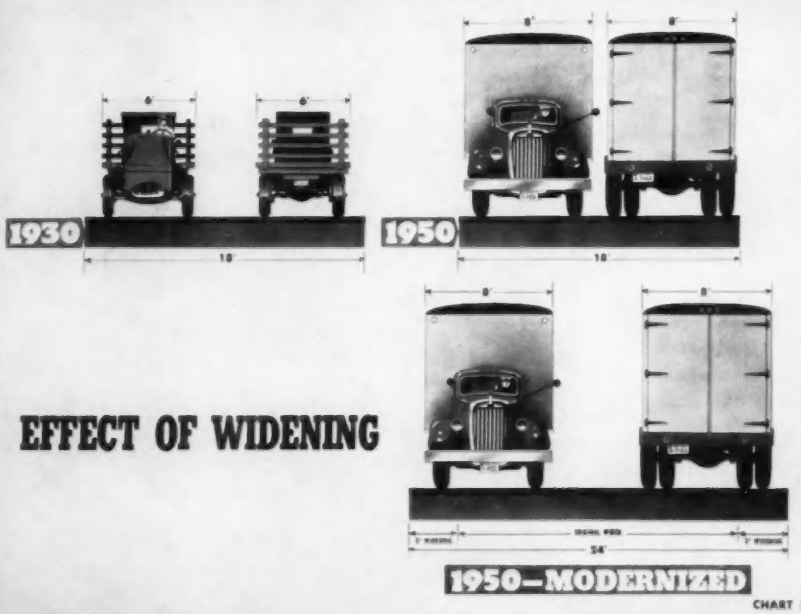
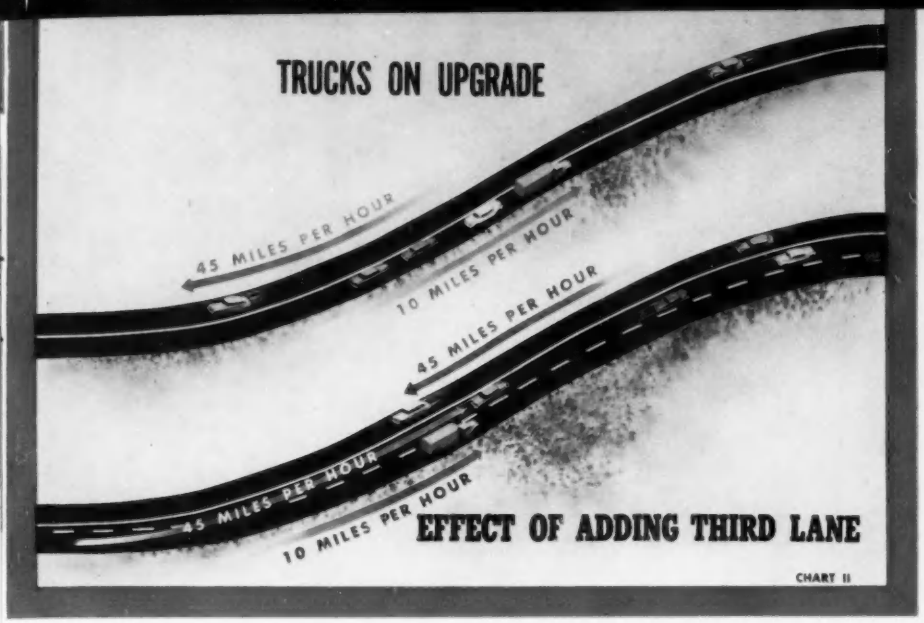


CHART 1



It is well to keep in mind that a lot of the impetus back of the demand for a new highway system comes from people who will profit by such a development, a fact that should be recognized as a matter of course. There is nothing dishonest about such promotion by contractors and industries; they will sell more of their products if new roads are constructed. For example, big machinery cannot be used in the salvage of old roads to the same extent as when new locations are selected and much earth movement is required. Big contractors with heavy equipment naturally desire big jobs to keep busy, while in order to sell more portland cement for culverts and bridges, it is preferable to have new locations, because making use of existing pavements does not provide much business of this kind.

ADEQUATE HIGHWAY IMPROVEMENTS

This promotional effort over the years has led to constant improvement in construction processes while the competition developed has often brought about lower costs. Today however, with heavy demand on all our facilities for military preparations, as well as for civilian needs, the public should not be called upon for unnecessary expenditures, which not only require additional taxation but also may use material and manpower vitally needed elsewhere. Let us then examine the situation, and out of all the confusing statements try to find the correct answer to the problem. In reviewing estimates of cost for the so-called rehabilitation of the highway system, one sees the sum of sixty billion dollars rather lightly handled, as though this money grew on trees. Of course, there is a breakdown of such totals showing individual items, and therefore a first step would be to examine some of them to see whether or not there is an alternative that will cost less money, consume less time, and permit more economy of materials.

EFFECT OF WIDENING

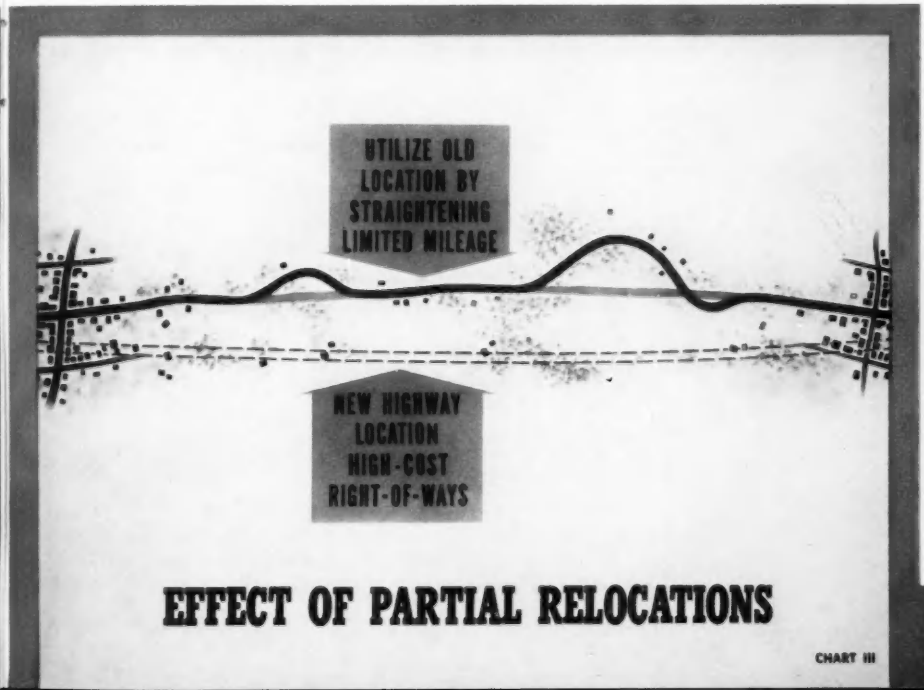
In order to determine the kind of improvement required, it is first necessary to make very careful analysis of traffic movement. Such analysis has led sometimes to opposing conclusions, but all will agree that much of the congestion occurs from the fact that there is not sufficient opportunity to move laterally on many old highways, whereby the faster moving vehicles may pass the slow moving ones in a safe manner. Twenty to thirty years ago, when a considerable mileage of highways was built, particularly those constructed of portland cement concrete, there were few vehicles over six feet in width, and consequently an eighteen foot road provided six feet of room for clearances. Today, with trucks at eight feet in width and with many passenger cars considerably more than six feet, this room has been reduced to not much over two feet. Approximately one-half of all main roads are still less than twenty feet wide.

The first need then is to regain the needed clearance, which usually does not require a new location, but merely widening the existing pavement in order to be in proportion to the new vehicles. Twenty-four feet of width—which would mean only about three feet more on either side of most of our two-lane roads—will provide this necessary space for maneuvering and for safe movement of traffic, and it can be accomplished at a rapid rate on existing right-of-way, at small cost. (See Chart I.)

EFFECT OF ADDING THIRD LANE

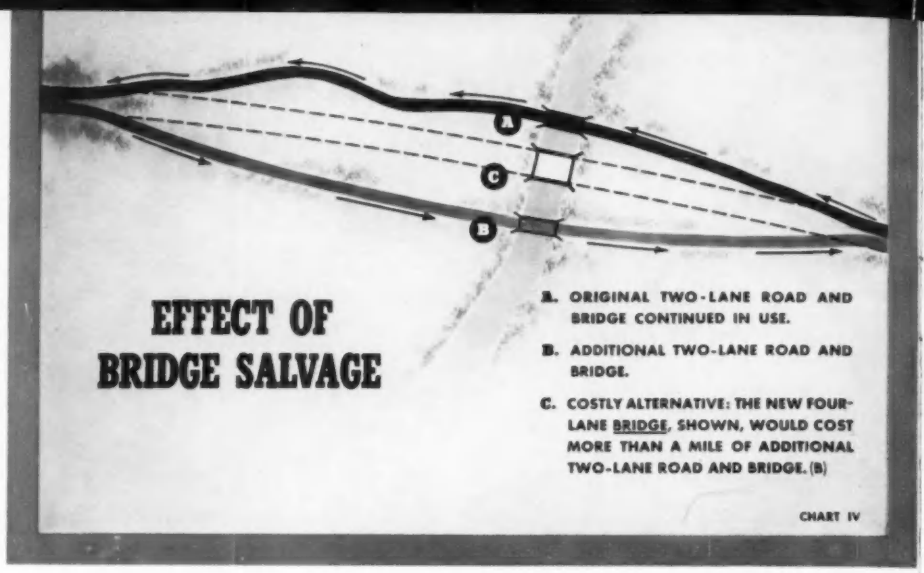
There are, of course, locations on any highway, particularly on hills and on sharp curves, where the slow vehicle causes a long procession, which is a dangerous situation. However, it is not necessary always either to relocate the road or to build an entirely new one to take care of this difficulty. There is required simply the building of a third lane on hills and other points of restricted sight distance, so that traffic can be reshuffled with the faster moving cars passing the slow moving vehicles in safety. (See Chart II.) Often short lengths of a dual highway can be constructed, at intervals of ten or fifteen miles, which will permit the same reshuffling of traffic. In other words, the idea that it takes a "hammer to kill a mosquito" is exemplified all too frequently in the claim that such restrictions in existing highways cannot be corrected except by throwing away the old highway entirely and building a new one.

Continued on page 12


UTILIZE OLD LOCATION BY STRAIGHTENING LIMITED MILEAGE
NEW HIGHWAY LOCATION HIGH-COST RIGHT-OF-WAYS
EFFECT OF PARTIAL RELOCATIONS
CHART III

EFFECT OF PARTIAL RELOCATION

Even where some relocation is required, careful study should be made *to determine the degree* in which the highway is inadequate and then to improve only those sections which are deficient. A recent twenty-five mile project illustrates the possible wide variation of planning in this regard. The first plan called for relocation over the entire length because of the number of steep hills and dangerous curves. More careful study, however, indicated that these hills and curves were concentrated in limited areas. After a resurvey, it was found possible to retain a large part of the old road with only partial relocation required, thus saving several million dollars over the first plan, yet without sacrifice of any real needs. (See Chart III.)


A
C
B
EFFECT OF BRIDGE SALVAGE
A. ORIGINAL TWO-LANE ROAD AND BRIDGE CONTINUED IN USE.
B. ADDITIONAL TWO-LANE ROAD AND BRIDGE.
C. COSTLY ALTERNATIVE: THE NEW FOUR-LANE BRIDGE, SHOWN, WOULD COST MORE THAN A MILE OF ADDITIONAL TWO-LANE ROAD AND BRIDGE. (B)
CHART IV

EFFECTS OF BRIDGE SALVAGE

Take the item of bridges. The total number of inadequate bridges that need to be replaced or reconstructed is very large. However this inadequacy takes several forms. One will be where the entire bridge is so light that it cannot be economically reconstructed, but in contrast there are many both steel and concrete bridges which are strong enough to carry the heaviest traffic, the inadequacy being that they are too narrow,—many of them with only eighteen foot roadways. Are these bridges obsolete, or can they be salvaged? In one state at least, a definite plan is being followed whereby the existing bridge is made one-way, and a new bridge (of about the same width) is constructed either up or down stream, with a long approach, so that in effect a dual highway is established. This is smart engineering, accomplishes all of the desired ends in respect to handling traffic safely, and yet the total cost of the placement of the new bridge as a one-way structure, with approaches as much as a mile in length, is less than building a single new bridge of the double width. (See Chart IV.)

HEAVY TRAFFIC ROADS SHOULD RECEIVE IMMEDIATE ATTENTION

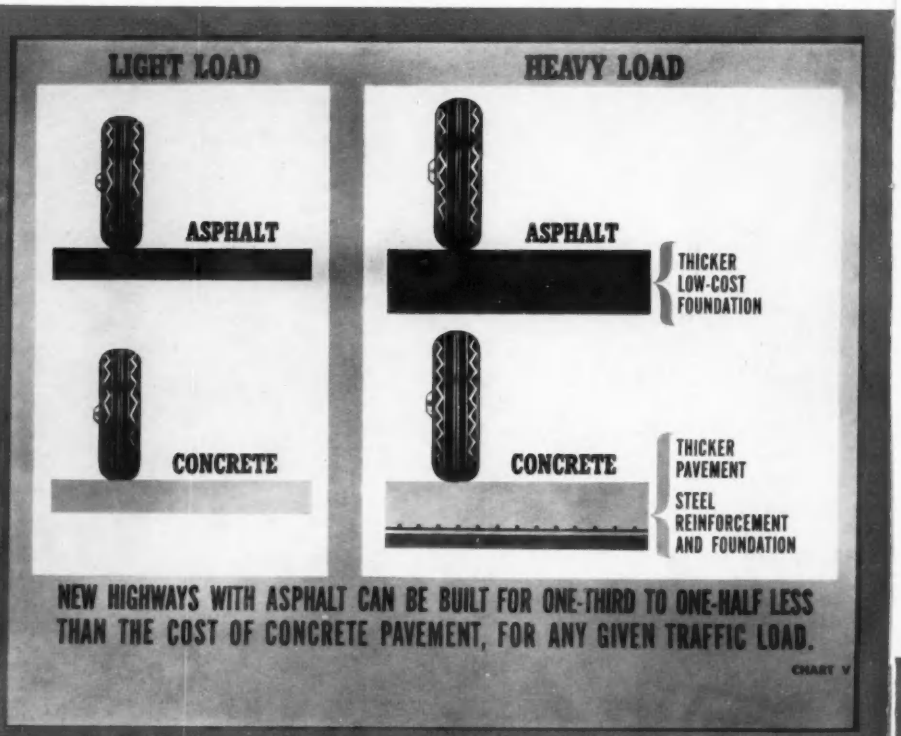
There are, of course, many existing roads which are entirely inadequate for traffic. This is true in and near metropolitan areas where complete relocation and reconstruction usually is the only answer. However, such mileage is but a very small percentage of the total, for when existing two-lane roads are modernized, they will carry upward of 4,000 vehicles a day in satisfactory manner. It is congestion on these limited mileages, and over which so many of us travel, that gives the impression that highways everywhere are inadequate. One of the great needs at present is to have a better balance in expenditures on roads of varying traffic density, rather than attempting to relocate the entire length of important routes whether they need it or not.

FLEXIBLE DESIGN NOW MORE ECONOMICAL THAN RIGID

In the construction of these new pavements, a flexible design will prove to be the most economical procedure, just as it is in widening and resurfacing work. For example, in the letting of the New Jersey Turnpike, the asphalt (flexible design) bid was nearly five and one half million dollars less than that on "concrete," while it has been well established that annual maintenance costs on such flexible heavy-duty pavements are also less. You may well ask, if this is the case, how did it happen that so many portland cement concrete pavements were built on the main highways? This is a fair question and must have a complete answer.

In the early nineteen thirties, when a large percentage of the "concrete" highways were built, the asphalt industry had neither developed the technique nor the equipment to compete for many of the primary roads under conditions which existed at that time. The "concrete" pavement, in 1930, was built smoother than the asphalt pavement, because the portland cement industry developed mechanical equipment for spreading earlier than did the asphalt industry. This situation is now entirely changed, and today the mechanical devices for spreading asphalt are superior to those employed for "concrete."

Asphalt also has a great advantage in the fact that it is laid without transverse joints. Almost everyone has had the common experience of getting out to look for a sup-



posed flat tire, only to discover that the bump was caused by the constant drag of the tires on the joints and cracks in the rigid "concrete" pavement. This happens with modern balloon tires, but did not occur with cord tires and lower rates of speed of twenty years ago.

ADDITIONAL ASPHALT ADVANTAGES

These improvements in asphalt surface finish have created general public acceptance, but from a cost standpoint *there is another development which will have a most profound effect as its significance becomes completely understood by road builders. It is the present-day understanding of the science of soil mechanics.* By a series of rather simple tests, it has become possible to predict rather exactly how any given soil will behave under changing traffic and climatic conditions. Now it so happens that asphalt pavements make one hundred per cent use of the support values of the natural earth subgrade, whereas the rigid "concrete" design makes only partial use of these values. This explains why old rigid pavements are showing such distress under present day truck traffic. As weight and volume have increased, the bridging value of "concrete" slabs is being exceeded, so they crack and break, because the pavement at the joints is not in contact with the subgrade beneath. This is one of the reasons back of the widespread effort to hold axle loads to 18,000 pounds or less.

To overcome this deficiency, "concrete" must be made much thicker for modern traffic, while for the asphalt design it is only necessary to thicken the low cost foundation. (See Chart V.) In view of the fact that soil and aggregates are much cheaper than either asphalt or portland cement, it naturally follows that the most economical design will be obtained where these values are used to the maximum advantage.

Asphalt has still another advantage in that it can be placed in any thickness, from as little as one-half inch to eight inches or more, and thus can be adjusted exactly according to the needs of the situation. Thus a 4" asphalt pavement, on low cost foundations, will carry not only 18,000 pounds, but 20,000 to 200,000 pounds on a single wheel, as shown so conclusively on the Stockton Airfield (California) Tests. It follows then, that by use of selected soils, either alone or in combination with foundations of stone and gravel, the asphalt wearing surface only needs to provide waterproofing and resistance to abrasion to be adequate for all traffic needs.

Just to give an example of what this means in the way of costs, let us examine recent contracts in two eastern states immediately contiguous to one another, where climatic and construction conditions are almost identical. In one state, the department awarded the contract for a "concrete" road at a cost of about $6.00 per square yard. In the adjacent state, the asphalt design was contracted at $3.00 per square yard, and incidentally for traffic heavier than in the first instance. This $3.00 may not sound like a lot of money but when you consider that a two-lane road, twenty-four feet wide, has approximately 16,000 square yards of area, the $3.00 becomes $50,000, and then when you multiply the $50,000, a mile by the thousands of miles within a state, it becomes immediately apparent that the savings run into many millions.

SAVINGS FOR THE TAXPAYER

Now what does this all mean so far as the taxpayer is concerned? When we say taxpayer we mean everyone, because the cost of highways is reflected in the price of every loaf of bread, every quart of milk, and everything else we eat, wear or use. If these costs are unnecessarily high, then we pay more than we should for even the very necessities. If we throw away highways that are capable of being salvaged we obviously have reduced our ability to make improvements in other places of need.

The public in general is very poorly informed as to this cost of highways and therefore susceptible to persuasion by the most vociferous. The big highway boosters are vociferous indeed, and it is necessary that the facts be clearly presented. This requires detailed knowledge of the conditions in each state. The Asphalt Institute, through its field organization, is acquainted with these requirements and is in position to advise accurately on the manner in which each state highway system should be modernized, improved, and extended. It is not necessary here to go into further details with regard to particular items, but I do believe that a careful examination into the facts will disclose that, where present estimates are on the order of forty to sixty billion dollars to produce a desired state of improvement in the nationwide highway system, a careful plan of modernizing the existing roads, plus only limited replacement with new ones, will reduce the need for such expenditure by a very substantial amount.

MORE ROADS FOR LESS MONEY ASSURED...

THROUGH PRACTICAL MODERNIZATION OF EXISTING HIGHWAY SYSTEM BY

WHETHER WIDENING AN EXISTING ROAD . . . OR . . . PROVIDING ENTIRELY NEW CONSTRUCTION

ASPHALT IS LOWEST IN COST

1 WIDENING AND RESURFACING
2 USE OF A 3rd LANE FOR SLOW-MOVING VEHICLES
3 PARTIAL INSTEAD OF COMPLETE RELOCATIONS
4 BRIDGE CONSTRUCTION ECONOMY
5 LOWERED COSTS THROUGHOUT WITH ASPHALT CONSTRUCTION

FRANK R. FIELD

Chairman of Executive Committee of The Asphalt Institute

Frank R. Field is serving as Chairman of the Executive Committee of The Asphalt Institute for 1951. In accordance with Institute practice, a representative from a member company in another division will hold this office during 1952. Mr. Field joined the Esso Standard Oil Company in 1923 and for fourteen years was Manager of asphalt sales in New Jersey. In 1937 he joined the New York staff, handling special sales of asphalt to the roofing and industrial trades. He became Assistant Manager in 1941, and in 1943 Manager of the entire asphalt operations of the company, which position he now holds.

ASPHALT IN 1951

The past year has marked a record increase in the activities and assistance rendered all fields of engineering by the Asphalt Institute, and a new high in the tonnage of petroleum asphalt marketed. Nineteen fifty-one will be a year of increased industrial and military activity, for which the Institute is prepared to enlarge the scope of its engineering assistance plan to aid in the preparedness program before us.

The role of asphalt is a vital one,—increasingly so in this time of national emergency when an efficient transportation system is an essential priority. Our present system of *arterial highways* has not been sufficiently modernized to carry the heavy loads that are required. Yet, we cannot return to the lighter traffic of a decade ago; we must strengthen them by modern methods such as resurfacing with *asphaltic* concrete and undersealing with asphalt the older concrete highways.

Such salvage is wise not only to insure our original investment but also to make the highways strong enough to carry the loads of the war economy which will be added to current public demand. This reclamation with asphalt can be carried on rapidly and should be the first line of thinking for improving Federal and State Highway main arteries.

Many of the vast *air bases* that have been built both at home and abroad, must be strengthened for the heavier bombers and troop carriers, and many will have to be lengthened for safe take-offs and landings of huge planes.

Ready in the emergency, the Asphalt Institute has available for instant use, the necessary technical information and literature, which it provides through its Engineering Staff, along educational, engineering and research lines.

We are prepared to render all possible services to the Federal Government and State Highway Departments. The asphalt industry, for its part, stands ready to furnish the necessary asphaltic materials, and is capable of considerable expansion in its all-out effort to meet an increased demand.

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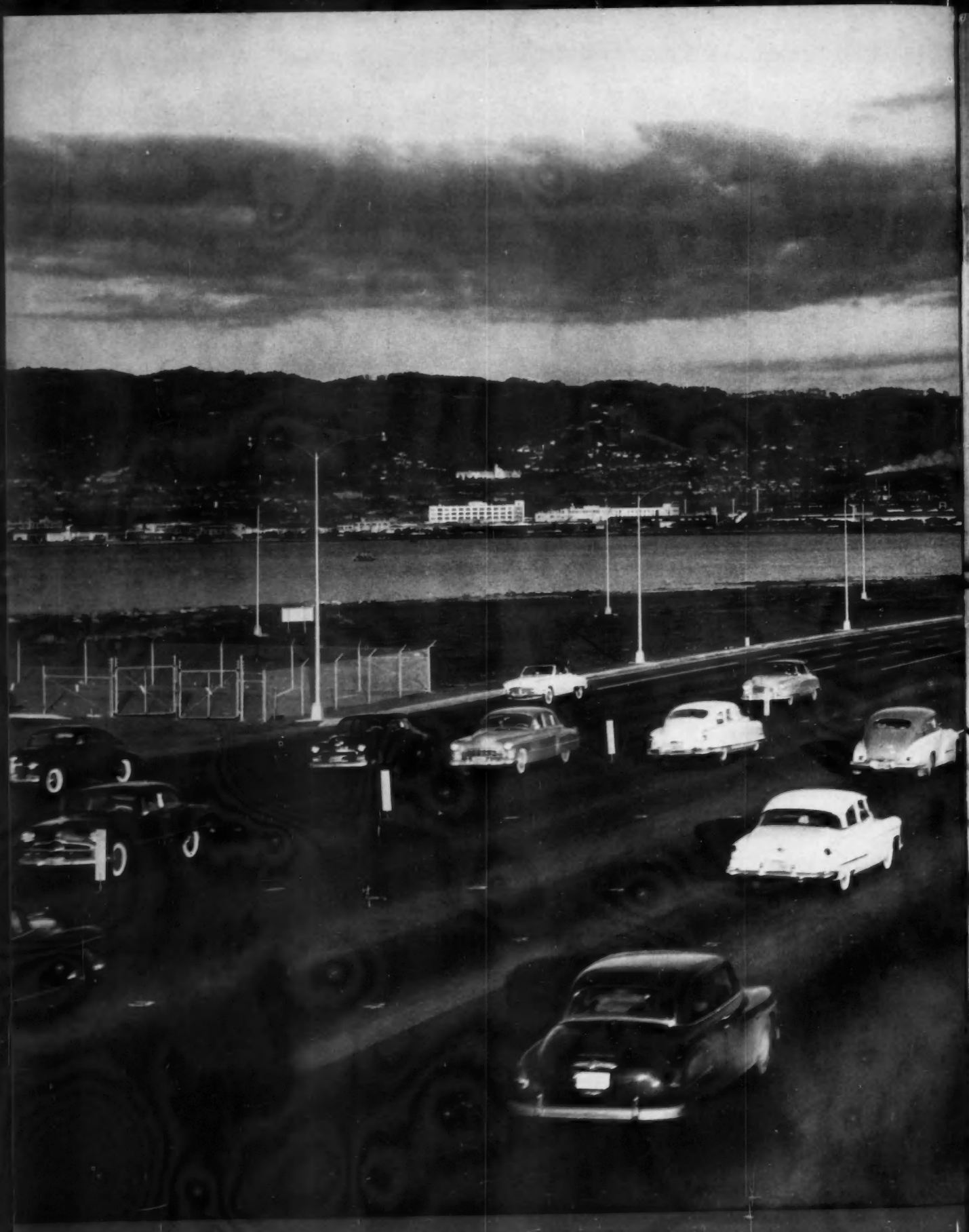
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